SOIL SURVEY OF THE SAN MARCOS AREA, TEXAS.

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DESCRIPTION OF THE AREA.

The area surveyed is purely an agricultural district. There are no manufacturing industries of any importance either in the cities within the area or those situated near by. The cattle industry is also of minor importance, and the whole area is dependent upon agriculture for its support. A failure of crops, therefore, means hardship to the people in the towns as well as to the farmers.

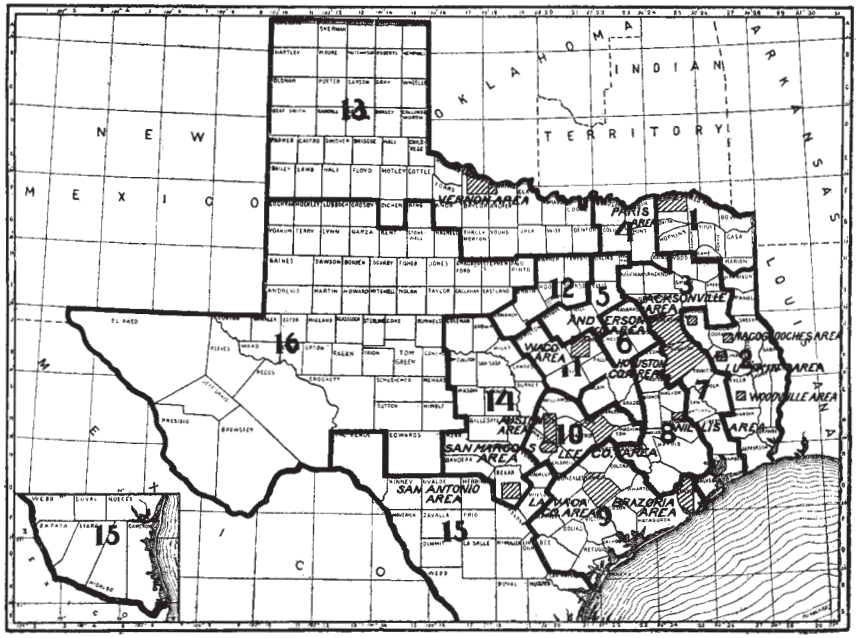

FIG. 17.—Sketch map showing location of the San Marcos area, Texas.

The area is situated in south-central Texas and includes parts of Hays, Caldwell, Bastrop, and Guadalupe counties, comprising a total area of 329,664 acres or approximately 515 square miles. The greater part of the northern boundary is formed by the Austin sheet, surveyed in 1904, the areas joining along parallel 30° N. The western boundary is irregular, but extends from the Hays County

line about 2 miles north of Buda in a general southwestern direction to the Comal County line, 1¼ miles northwest of Hunter. It then follows the county line to the extreme southern part of Hays County. The southern boundary extends from the southern extremity of Hays County due east, intersecting the eastern boundary, which is formed by meridian 97° 30′ west longitude, at a point about 5 miles southeast of Tilmon.

The area embraces a narrow strip of the rough, hilly section of Hays County, locally known as the "Mountains." The hilly region rises abruptly from the rolling prairie lands and extends westward in a series of steep rocky hills which have only a shallow covering of soil and are of small agricultural value. The part of this region embraced by the survey consists of a narrow strip having an average width of about 2 miles, which extends along the western boundary in a general northeast and southwest direction. The topography is rough and broken. The small streams flow in deep gorges or small canyons and the hillsides are steep and eroded. Fragments of limestone are scattered over the surface and small areas of rock outcrop occur frequently.

East of the mountains is the black prairie belt, which extends almost to the eastern boundary of the area. The topography of this section is gently rolling and the whole prairie has the general appearance of an almost level plain. The hills are low and rounded, with broad level areas intervening, and with the exception of the abrupt slopes along the valley of Plum Creek the uplands slope gently toward the small stream courses.

The eastern part of the area is slightly more rolling than the black prairie section, and the hills and ridges which are not under cultivation are covered with a heavy growth of scrub-oak and post-oak timber. Here the greatest amount of erosion has taken place. The sandy soil is frequently washed from the steep hillsides, and deep gullies are eroded in the stiff clay subsoil.

The extreme southeastern corner of the area surveyed is crossed by a series of ridges and rounded knobs, locally known as the "sand hills." These hills rise to an elevation of 75 to 100 feet above the surrounding country, and are covered by a heavy growth of post and scrub oak. The summits of the knobs are usually capped with outcrops of massive red or brown sandstone and fragments of sandstone occur in the deep white sand which occupies the hills and ridges of this section of the area. A very small percentage of the "sand hills" is under cultivation, and the land is valued mainly for the heavy growth of timber it supports.

The San Marcos River receives the drainage waters of the entire area. This river rises from large springs at the base of the mountains near the city of San Marcos and flows in a southeasterly direc-

tion, leaving the area near the town of Fentress. The Blanco River, which drains the northwestern part of the area, empties into the San Marcos River a few miles below the city of San Marcos. These two streams are perennial and furnish an abundance of water for the towns situated in the valleys and for irrigation purposes. The northern and eastern sections are drained by Plum Creek and its principal tributaries, Dry Creek, Tenney Creek, and Elm Creek. Plum Creek also flows in a southeasterly direction and empties into the San Marcos River some distance south of the area. A considerable proportion of the southern part of the area is drained by Clear Fork and West Fork creeks, which are also tributaries of Plum Creek, entering into that stream south of the area surveyed. These principal streams and their numerous small tributaries furnish an excellent natural drainage system for the whole region. The stream valleys are frequently overflowed at times of heavy rains, but there are no low swampy areas requiring artificial drainage.

The early settlers were from Alabama, Missouri, Tennessee, and other southern States, and the greater part of the present population are descendants of these settlers or have come from the older States in more recent years. A great many Germans, who have moved into this region from the German Colony founded at New Braunfels in 1845, are also found among the present population. Many Mexicans are found both in the towns and country throughout the black prairie belt, while the negro population outside of the small cities and towns is confined mainly to the timbered region in the eastern part of the area. The entire district surveyed is comparatively thickly settled, especially the valley of the San Marcos River and the black prairie belt. The most of these valley and prairie lands are under cultivation and numerous small towns, centers of trade for the surrounding country, are scattered throughout the area. The timbered districts are not so thickly settled. The soils are less productive, and the expense and labor involved in clearing the land has caused the settlement to be much slower than in the black prairie region.

San Marcos and Lockhart are the principal towns in the area, but Kyle, Maxwell, and Dale are shipping points of considerable local importance. San Marcos is situated at the head of the San Marcos River in the western part of the area and is the most important shipping point in the area. Lockhart is situated in the black prairie belt in the east central part of the area. It is surrounded by a diversity of soils and is the center of trade for one of the most prosperous sections of the district surveyed.

The three railroads which traverse the area furnish ample facilities for transporting the products of every locality to the larger markets, both north and south. Two trunk-line railroads, the

International and Great Northern and the Missouri, Kansas and Texas, give the larger towns excellent freight and passenger service, and a branch of the San Antonio and Aransas Pass Railroad connects Lockhart with the Southern Pacific Railroad at a point just south of the area surveyed. Arrangements have been made for the construction of an electric road down the valley of the San Marcos River, connecting San Marcos with the Southern Pacific and the San Antonio and Aransas Pass at Luling. This road will aid materially in developing the trucking industry on the irrigable lands of the San Marcos Valley. A well-kept system of public roads connects the local shipping points with every locality in the area, and strong, durable bridges have been constructed over the small streams and rivers. A few of the more important roads have been macadamized for some distance out of the leading towns; otherwise those traversing the black prairie belt become almost impassable after heavy or continuous rains. Lockhart and San Marcos are the local markets for most of the products of the area, but the cotton, cattle, and hogs are eventually shipped to distant markets. The onions and other truck crops are shipped in carloads to Kansas City, St. Louis, and other large northern markets. Cotton is sold to local buyers and is shipped via Galveston to various parts of the United States or to foreign countries. The cattle are mainly sold on the St. Louis or Kansas City markets, but a few are also marketed at Fort Worth. Since the packing houses were established at Fort Worth the raising of hogs for that market has become an important industry. No ranches are devoted exclusively to hog raising, but many farmers, especially those located on the lighter soils in the eastern part of the area, annually raise a large number. The small yield of cotton obtained in this part of the area, due to the sandy character of the soil and to the ravages of the Mexican cotton boll weevil, has helped to develop this industry, and the raising of hogs, combined with the growing of peanuts, has proved very profitable. The raising of poultry has also become an important industry in parts of the area and is rapidly growing. All poultry and eggs not in demand on the local markets are shipped to Houston, New Orleans, and San Antonio.

The farmers in every section of the area are in a very prosperous condition. For three years prior to the present season of 1905–6 the cotton crop was greatly damaged by the boll weevil and a profitable yield was uncertain, but during the present season the large crop and good prices have put the farmers in a better financial condition than has been known for years.

CLIMATE.

The climate of the area is very mild, the temperature for the entire year averaging about 67° F. January and February, the coldest months, have an average temperature of only about 50° F. The hottest months, July and August, have an average temperature of about 84° F., but the strong breezes from the Gulf temper the summer heat. During the winter months cold north winds, locally known as "northers," frequently cause the temperature to drop several degrees in the course of a few hours, but the cold periods are of short duration, and the temperature rarely reaches the freezing point. The following table, compiled from records of the Weather Bureau, shows the normal monthly and annual temperature and precipitation. These records were kept at New Braunfels, situated about 9 miles southwest, and at Austin, situated about 25 miles north, of the area surveyed.

Normal monthly and annual temperature and precipitation.

Month.	Austin.		New Braunfels.		Month.	Austin.		New Braunfels.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	In.	°F.	In.		°F.	In.	°F.	In.
January	48.7	2.47	51.6	2.06	August	84.1	2.43	82.1	2.57
February	52.7	1.88	53.2	1.20	September	78.6	3.72	77.5	3.08
March	50.2	2.22	61.1	1.56	October	69.3	2.77	68.8	1.92
April	69.0	4.05	68.5	3.63	November	59.0	2.26	58.5	1.87
May	76.5	4.40	74.6	3.32	December	52.2	2.80	52.9	2.20
June	82.2	2.51	80.8	3.39	Year	68.1	33.81	67.6	29.39
July	85.1	2.30	83.2	2.59					

The dates of the first and last killing frosts as observed at Austin and New Braunfels are given in the following table, which indicates that there is a period of about eight months during which vegetation is not seriously damaged by frosts:

Date of first and last killing frost.

Year.	Austin.		New Braunfels.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1898	Jan. 31	Dec. 4	Mar. 5	Dec. 5
1899	Feb. 27	Nov. 3	Mar. 6	Nov. 3
1900	Mar. 16	Nov. 11	Mar. 1	Nov. 12
1901	Mar. 6	Dec. 13	Mar. 5	Dec. 10
1902	....do...	Dec. 3	Mar. 6	Dec. 5
1903	Feb. 18	Nov. 18	Feb. 28	Nov. 18
1904	Mar. 4	Oct. 12	Feb. 21	Nov. 12
Average	Feb. 27	Nov. 18	Mar. 2	Nov. 22

AGRICULTURE.

When the area was first settled, the prairies were used as open ranges for cattle and the raising of stock was the principal industry. The growing of cotton, however, began with the first settlement, and small areas of the valley lands were cultivated to this crop as early as 1847. The valley lands were first put under cultivation, as the black prairies were considered better adapted to stock raising than to agricultural purposes. At first cotton was grown to a very limited extent, because the markets, Port Lavaca and Galveston, were distant, and the product had to be transported overland by means of ox teams. When the railroads reached Austin, San Antonio, and other points at no great distance from the area, greatly increasing the transportation facilities, the agricultural development progressed rapidly, and by the time the railroads reached the area, in 1882, stock raising had become of small importance, and the great open ranges were fenced off into farming lands. Wheat was grown to a limited extent by the early settlers, but cotton was then, and is now, the principal crop grown on every type of soil.

Irrigation has been recently introduced in the growing of truck crops in the valleys of the San Marcos and Blanco rivers. Onions and early Irish potatoes are the principal crops grown, but cotton, corn, alfalfa, oats, strawberries, and cabbage are also grown on the irrigated lands to a limited extent.

The recent ravages of the cotton boll weevil have brought about a greater diversification of crops, particularly on the light sandy soils where the crop suffered the greatest damage. The Susquehanna fine sandy loam, which is the most important of the lighter soils, is well adapted to melons, vegetables, sweet potatoes, berries, and fruit. These crops are now successfully grown and the acreage planted in cotton has greatly decreased. Cowpeas and sorghum also do well, and peanuts grown for fattening hogs are rapidly becoming one of the principal crops on the light sandy soils. Watermelons also do well, and are extensively grown for the local markets. Still the cotton crop is the main source of revenue to the farmers of the area. For many years it was grown on every type of soil, almost to the exclusion of all other crops, and at present it is grown on almost every farm in the area. The heavy black clay soils, which occupy about three-fourths of the area surveyed, are best adapted to the production of cotton and are devoted almost exclusively to this crop. These heavy clay soils are very productive and give profitable yields of cotton each year without the aid of fertilizers and without any rotation of crops being practiced. The corn grown in the area little more than supplies the local demand, and oats, which are grown to a very limited extent, are seldom thrashed, but are used mainly for

pasturage or fed in the sheaf. Sorghum, millet, or Johnson grass is grown on almost every farm for feed.

When the cotton crop is a failure on the heavy soils the farmers have no other source of income, and the financial condition of the whole area is seriously affected. The light sandy soils are, as a rule, much less productive than the heavy clays, and the farmers cultivating the heavier soils are usually in a more prosperous condition. However, the growing of vegetables and other crops besides cotton on these lighter soils is causing them to increase in value, and the financial condition of the farmers in this section of the area is steadily improving.

There is little or no systematic rotation of crops practiced on any type of soil in the area, but the decline in productivity which must result from continuously growing one crop has as yet been shown to a very small extent by the heavy clay soils. On the lighter soils, however, corn or sorghum is often rotated with cotton, the usual rotation being cotton two or three years and corn or sorghum one year. Cowpeas do well on almost every type of soil in the area, and when rotated with the other crops grown have proved beneficial in keeping the soils in a productive state.

As in all districts where land is cheap and can be bought in large tracts, where farming is conducted on a large scale, and where the soils are naturally productive, very little attention is paid to agricultural methods. Crops are planted and cultivated with more regard to the saving of labor and expense than to the use of proper methods of cultivation. Plowing in most parts of the area is shallow, the average depth being about 4 inches. After plowing, the field is often left in ridges for a considerable length of time before it is prepared for the planting of the crop, and the large surface area exposed causes a rapid loss of the soil moisture by evaporation. Deeper plowing would be beneficial on all but the loose sandy soils, as it would aid in the conservation of the soil moisture. The rainfall in the area is usually sufficient for the production of all crops grown, but frequently it is not well distributed. Periods of from three to five weeks occur during which there is little or no rainfall, while in late summer occasional droughts are of longer duration. A lack of rainfall at certain stages in the growth of crops materially affects the yields, and methods which would conserve the soil moisture for use of the crops at such times would be of great benefit. A shallow cultivation as soon as possible after rains, forming a mulch or "dust blanket" and breaking capillary connection between the deeper soil and the surface, would aid in the conservation of moisture for the future use of the crops.

The usual method of preparing the field for cotton is to leave a low ridge on which the crop is planted. This method is uniformly used

on the level or poorly drained areas, but level cultivation in the growing of this crop is coming into more general use. Level cultivation is usually practiced in the growing of corn, and where the soil is well drained the crop is sometimes planted in a shallow furrow between low ridges.

The supply of labor is usually plentiful, except during the cotton-picking season, and consists mainly of Mexicans. A few negroes are also employed, but the large Mexican population furnishes the bulk of the farm labor throughout the area. During the cotton-picking season the demand for laborers often exceeds the supply. At this season help is imported from outside, and many pickers are employed who are not regular farm laborers. From 50 to 75 cents a day is the average price paid for farm labor, but cotton pickers are paid according to the number of pounds picked, usually from 40 to 60 cents per 100 pounds. When cotton is thinned or "chopped out" the laborers are paid by the acre, about 50 cents per acre being the average wage for this work Laborers are seldom hired for long periods, but a few are hired by the month and receive from $15 to $18 a month.

The greater part of the land is rented on shares. The owner usually furnishes the land, work animals, and seed, and receives one-half of the crop. When the owner furnishes the land only, he receives one-fourth of the cotton and one-third of the grain. In either case the landowner has the privilege of deciding how many acres of the land must be cultivated to each crop, and as a a rule he insists on the cultivation of cotton on a very large percentage, if not all, of the acreage rented. A small acreage in the area is annually rented for cash, and a number of tenants prefer this plan to farming on shares, as they can then plant such crops as they desire, and are not obliged to grow cotton exclusively. When rented for cash, about $4 an acre is paid for the clay soils and $3 an acre for the sandy lands.

The census of 1900 gives the average size of the farms in Hays County as 250.2 acres, but there are many large farms in the rough and hilly regions of the county which are adapted mainly to stock raising. In the black prairie region of the area it is estimated that there is a landowner for approximately every 150 to 200 acres.

There is a great variation in the value of the different types of soil which occur in the area. Some of the sandy and stony types which are not well adapted to agricultural purposes and are located at a distance from the markets and railroads are valued at less than $5 an acre. The heavier soils occupying the valley of the San Marcos River, which have been highly improved and are under irrigation, are valued at from $250 to $300 an acre. The average value of the black prairie lands is about $40 or $50 an acre.

Deeper plowing, a systematic rotation of crops, and the use of methods for the conservation of the soil moisture are suggested for the improvement of the agriculture of the area.

SOILS.

Eleven types of soil occur in the area, varying in texture from a loose, incoherent sand to a stiff, heavy clay. A few of the soils are of low agricultural value, but the majority are very productive, and when well managed and properly cultivated yield good crops. Most of the soils are formed from material derived from the weathering of the underlying geological formations, and the distribution of the various types follows very closely the geology of the area.

The following table gives the name and the actual and relative extent of these soil types:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Houston black clay	128,896	39.1	Susquehanna gravel	6,528	2.0
Susquehanna fine sandy loam	60,160	18.2	Houston clay	6,080	1.9
Houston gravelly clay	48,384	14.7	Blanco loam	5,376	1.6
Houston loam	25,216	7.6	Sandhill	2,112	.6
Crawford stony clay	18,816	5.7	Rock outcrop	128	.1
Crawford silt clay	18,048	5.5	Total	329,664	
Wabash clay	9,920	3.0			

Running north and south across the eastern end of the area is a broad belt of sand, sandstone, and red or brown clays composing geological formations of the Eocene period. The weathering of these formations has given rise to the Susquehanna fine sandy loam, the most important of the light sandy soils of the area. These formations extend into the southeastern corner of the Austin area and form the material from which a similar soil is derived. This sand and clay formation is more easily eroded than the heavy marly clay of the black prairie region, and more care is necessary to keep the soil from washing and to check the formation of deep gullies on the steeper hillsides.

A broad belt of unstratified calcareous clays and clay marls of the Upper Cretaceous period, known as the Taylor marl formation, extends diagonally across the center of the area in a northeast and southwest direction. This formation, which is several hundred feet thick in some locations, weathers very rapidly on exposure, and forms a very stiff black clay soil, but this has been modified on the higher ridges by the remains of an old gravel deposit, necessitating the separation of the heavy, black prairie soils into two types, called the Houston black clay and the Houston gravelly clay.

Along the western border of the area is a narrow belt of the hard white limestone of the Edwards formation. The weathering of this formation has given rise to the Crawford stony clay, one of the poorest soils of the area. Large fragments of honeycombed limestone and small fragments of chert characteristic of this soil and of the geological formation underlying it are scattered over the surface.

The almost unbroken area of Susquehanna fine sandy loam in the eastern part of the survey, the broad belt of Houston black clay in the northern and central part, the intermixed areas of Houston black clay and Houston gravelly clay in the southwestern corner, and the belt of Crawford stony clay along the western border form the four largest and most striking features of the soil map accompanying this report.

In the northwestern corner of the area is a massive formation of white chalky limestone known as the Austin chalk. This gives rise to the Houston clay and forms similar soils in the Austin, Waco, and San Antonio areas. The Austin chalk is seldom more than 2 feet below the surface of the soil and the upper surface of the rock is always in a soft, partially decomposed condition. The agricultural value of the Houston clay depends to a marked degree on the topographical position it occupies. Where a field is level or occupies a slight depression the soil is deep enough for successful cultivation, but where the topography is rolling the soil suffers greatly from erosion.

The Crawford silt clay, which occurs along the valley of the San Marcos River, is not uniformly as heavy as the brown limestone clay of the Waco area derived from the weathering of the same formation. It has been modified to some extent by the addition of lighter material along its line of contact with the Blanco loam, and while the Crawford clay of the Waco area was derived entirely from the underlying limestone, the position of the Crawford silt clay in the San Marcos Valley and its general trend, following that of the river, indicate that a considerable part of the material forming this soil has been transported from other localities.

The soils along the smaller streams are subject to frequent overflow and are all of alluvial origin. The texture varies slightly according to the character of the soil and the geological formation of the localities through which the stream flows. Frequently a stream or one of its main tributaries traverses an area of light sandy material, and this is washed down and mixed with that derived from the black prairie soils, giving rise to small areas which have a more loamy texture than the typical overflowed lands. The alluvial deposits occur only along the larger streams which flow partly or wholly through the black prairie belt, and the greater part of the soil is derived from the material which composes the heavy upland clays.

As a whole the heavier soils of the area are the best for general farming purposes. They retain their productiveness without the aid of fertilizers, withstand droughts better than the lighter soils, and produce larger yields of the staple crops. The light, sandy soils, however, are adapted to a greater variety of crops and their value is steadily increasing.

HOUSTON BLACK CLAY.

The soil of the Houston black clay, locally known as "black waxy" land, is a heavy black clay with an average depth of 10 to 12 inches. The surface, when well cultivated, breaks up into a loamy friable condition and has the general appearance of a soil of lighter texture. On the other hand, when in a wet condition it is very stiff and tenacious, and if cultivated too early after rains it clods and bakes, making it difficult to reduce it to good tilth and lessening its natural productiveness to a considerable extent. In areas which are not continuously under cultivation the surface is also hard and sun cracked.

At about 10 or 12 inches the soil grades into a stiff, heavy clay subsoil which gradually becomes stiffer and lighter colored as the depth increases. At 25 to 36 inches this subsoil consists of a stiff, tenacious clay which contains little organic matter and is much heavier than the upper portion of the 3-foot section. A few small, rounded gravel are sometimes found scattered over the surface and mixed with the soil, but the greater part of the type, especially the more level areas, is uniform in texture and free from gravel or other modifying agencies. Where the topography is more rolling a larger percentage of gravel and small cobbles is encountered in the soil, but where these occur to such an extent as to influence the agricultural value or alter the general character of the soil the areas have been mapped as a separate type. On the rounded summits and slopes of some of the steeper hills or ridges the Houston black clay has a slightly lighter color than the main body of the type. This is merely a slight difference in color, due to the fact that greater erosion has taken place on the hillsides, and the texture varies very little from that of the typical soil. The black upper soil has been washed from these steep slopes and the present soil, formed from the weathering of the lighter colored subsoil, contains less organic matter than the type as a whole. These areas, however, are of very small extent and occur only in a few localities.

The Houston black clay occupies a considerable proportion of the central part of the area. A large body occurs in the northern part of the area, reaching from Kyle almost to Lytton Springs. This area extends south and occupies almost the entire central and east-central part of the region surveyed. A few isolated ridges of Houston gravelly clay and the narrow strips of alluvial soils along the small

stream courses are all that prevent this type of soil from extending in one unbroken tract from the northern to the southern boundaries of the area. Areas of less extent are encountered in all parts of the survey, especially in the southwestern part, where this soil occupies the more level tracts lying between the rounded hills and low ridges. The topographic features vary from low, rounded hills and ridges to almost level or very gently undulating prairies. The hills and ridges are seldom steep enough to cause the soils to be seriously damaged by erosion, but the topography of the whole is rolling enough to insure good natural drainage. Many small intermittent streams traverse the prairies and at times of heavy rainfall serve to carry the excess water to the larger stream courses.

The Houston black clay is derived from the Taylor marl formation, a member of the Cretaceous. The original material is a stiff calcareous clay, and the resulting soil has the characteristic productiveness of soils derived from limestone.

The cotton "root rot" damages the cotton and potato crops to a considerable extent on small areas which occur in every locality embraced by this type. The loss on account of this fungous growth is always greater during a wet season, and the affected areas occur on the better drained hillsides, as well as on the more level areas.

The Houston black clay is the most valuable general farming soil in the area, being very productive and extremely durable.[a] It produces profitable yields in both wet and dry seasons and is well adapted to cotton, corn, and forage crops. Oats are grown to a very limited extent, and are mainly used as pasturage for stock.

[a] Samples of this soil, which is the typical black prairie soil of the region, and considered to be the most valuable type of general farming land in this section of the State, were collected in four localities. Upon none of them have fertilizers ever been used, nor had they been subjected to a systematic rotation; indeed, one of them has been cultivated in cotton for twenty-five years, the other varying between that staple and corn at irregular periods, yielding, however, about one-half bale of cotton and about 35 bushels of corn to the acre.

The manurial requirements of this soil, as represented by these samples, was made the subject of a study by means of the wire-basket method in which wheat plants were used as an indicator, and while the results are held to be applicable only to the fields from which the samples are taken and for wheat or a similar crop, yet it is highly probable that they would hold good for other crops grown upon this type of soil in this and adjacent areas.

When nitrate of soda, sulphate of potash, and acid phosphate were used singly and in various combinations, nitrate of soda used alone gave the greatest increase of any of these salts, and in combination with any one of the others its influence was not increased, but when combined with both the results were very apparent, and the increase was greater still when lime was added to the combination of all three. Manure gave very good results, but not equal to the complete fertilizer and lime, which, in turn, was not equal to the cowpeas and lime. Lime alone was beneficial, but not so much so as when used in combination with cowpeas or with complete fertilizer.

The more level areas are considered slightly more productive than the rolling land, mainly because the soil is never eroded and the crops suffer less in times of drought. Cotton is the principal crop grown on this soil, the average yield being one-half of a bale per acre. When the soil is well cultivated and a rotation of crops is practiced a yield of three-fourths of a bale per acre has been continuously obtained, and an average yield of 1 bale per acre is not uncommon in very favorable seasons. A very small percentage of the cotton grown on this type was damaged by the boll weevil during the present season of 1905–6, and it has never been damaged to as great an extent as that grown on the bottom lands or in the timbered sections of the area. Corn is sometimes seriously damaged by drought, but during a season of average rainfall it yields about 35 bushels per acre. During a very favorable season, however, the well-cultivated areas produce from 40 to 50 bushels of corn per acre. Johnson grass and sorghum are extensively grown for forage. The Johnson grass yields from three to four cuttings each season, and from 1 to 1½ tons per acre is secured at each cutting. Two cuttings are obtained from sorghum, and while a small yield is obtained from the second it makes a better feed than that obtained from the first cutting. The average yields are from 3 to 4 tons per acre for the first and 1 or 1½ tons per acre for the second cutting. A few peaches and plums are grown for home use, and tomatoes and chili peppers are grown to a limited extent.

The natural growth is mesquite and a species of cactus, which grows very thickly on the uncultivated areas. The price of this land varies according to its location and improvement, but the average price throughout the area is about $40 an acre.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Houston black clay.

Number.	Description	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14496, 14500, 14502.	Soil.....	0.4	0.9	0.6	4.2	8.8	46.1	38.4
14497, 14501, 14503.	Subsoil....	.9	1.1	.5	3.2	7.9	46.8	39.2

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 14500, 1.4 per cent; No. 14501, 1.3 per cent; No. 14503, 1.0 per cent.

HOUSTON GRAVELLY CLAY.

The Houston gravelly clay consists of a heavy black clay soil about 10 inches deep, with a large quantity of rounded gravel and small cobbles scattered over the surface and mixed with the soil. This

grades into a stiff, tenacious clay subsoil of lighter color than the soil, which rapidly becomes stiffer and more tenacious as the depth increases. The subsoil is of a dark drab color and usually contains a much smaller percentage of gravel than the surface soil, but thin beds of gravel are sometimes encountered at a depth of 2 or 3 feet. However, loose, rounded cobbles are usually found embedded in the heavy clay throughout the entire 3-foot section.

From 30 to 50 per cent of the surface is sometimes covered by rounded gravel, but as a rule the content is much lower, not more than 15 per cent. The gravel is not so noticeable on areas which have been recently cultivated, as it is turned under and mixed with the soil.

The soil breaks up into the same loamy, friable condition as the Houston black clay, and the stones when not too numerous are considered by many to be more beneficial than harmful, as they tend to reduce evaporation, with the result that the Houston gravelly clay suffers less from drought than the other heavy clay lands occupying the same topographical position.

The largest area of this type occurs in the southwestern part of the survey, where it covers a large proportion of the rolling prairies, but smaller areas are found on the ridges and higher elevations in almost every section of the black prairie belt.

The principal topographic features of this type consist of low, rounded hills and ridges, but it also occupies areas of a less rolling character on the higher plateaus of the black prairie. The soil suffers very little from erosion and is naturally well drained.

The Houston gravelly clay is derived from the remains of an old gravel deposit which was laid down over the calcareous clay marls which form the black prairie region. This gravel formation has been gradually worn away over the greater part of the area it once covered, and only occurs as thin layers capping the higher knolls and ridges or scattering over the surface of the black clay soil which occupies the more rolling sections of the upland prairie.

With the exception of the small areas mentioned above as capping some of the higher elevations the soil is very productive, and when well cultivated often produces yields equal to those obtained from any of the upland soils. It is not valued as highly as the Houston black clay, because the presence of the gravel makes it more difficult to cultivate.

Cotton, corn, sorghum, and Johnson grass are the principal crops grown. Very little rotation of crops is practiced. Cotton is usually grown on a field for three or four consecutive years; this is followed by corn or sorghum for one year and then by cotton. Cotton gives an average yield of one-half bale per acre, and the crop is seldom damaged to any great extent by the boll weevil. Corn

yields about 35 bushels per acre during a season of average rainfall, but in a very favorable season yields of 40 to 50 bushels per acre have been secured. Sorghum yields an average of 3 tons per acre for the first and about 1½ tons per acre for the second cutting. Some oats are grown, and the crop is used as pasturage for stock. A few peaches and plums do fairly well, but the soil is not well adapted to peaches. Johnson grass is grown for feed, but is very difficult to kill when it has once been sown, and it makes the cultivation of any other crop very difficult.

Mesquite is the natural timber growth on this type, and a few live oak and post oak trees occur on some of the more gravelly areas. The price of this land varies from $25 to $40 an acre, according to its topography, the amount of gravel present, and its location.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Houston gravelly clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14504, 14506.....	Soil.....	0.2	1.2	0.5	3.5	9.2	46.4	38.3
14505, 14507.....	Subsoil.....	.4	.8	.3	2.4.	5.9	45.9	44.0

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 14504, 51.9 per cent; No. 14505, 13.5 per cent.

SUSQUEHANNA FINE SANDY LOAM.

The soil of the Susquehanna fine sandy loam to a depth of 10 to 15 inches is a gray to light-brown fine sandy loam, sometimes having a few small gravel scattered over the surface. It is easily cultivated, but has a tendency to run together after heavy rains, becoming as compact as the areas not under cultivation. The subsoil is a stiff, impervious clay of a dark-red to brown color. It has a slightly laminated structure and can be separated into very thin layers of clay with fine or very fine sand between them. The thin sandy strata in the clay often give it a slightly mottled appearance. The upper part of the subsoil contains a considerable amount of sand derived from the soil, but it rapidly becomes stiff and impervious as the depth increases and water penetrates it very slowly, causing the soil to remain in a cold, soggy condition for some time after rains.

The Susquehanna fine sandy loam occupies the greater part of the extreme eastern section of the area. The larger areas are found on the eastern side of Plum Creek, covering the greater proportion of the rolling upland between Lytton Springs and the southern boundary of the area. A few smaller areas occur on the west side of Plum Creek in the vicinity of Burdettes Well.

The topography is quite rolling. The hills and ridges are low and rounded, and the slopes toward the small valleys or more level areas are seldom steep. The sandy soil, however, is easily eroded, and areas frequently occur along the hillsides where the soil has been washed down to the lower levels, leaving the red or brown clay subsoil exposed on the surface. Deep gullies and erosions are frequently cut through the subsoil on the steeper slopes, and the many small streams which traverse this section of the area have cut deep channels through the underlying clay.

The geological formation from which this soil is derived consists of sand, sandstone, and red to brown sandy clays belonging to the Eocene period. Outcrops of the fine-grained sandstone are frequently seen in the larger areas of this type, and small fragments in a partially decomposed condition are often encountered scattered over the surface of some of the higher ridges. The sandstone weathers rapidly on exposure, and has entered largely into the composition of the sandy soil.

It is believed that underdrainage on the more level areas would enable the soil to withstand drought better. This would also reclaim the soil from the wet, soggy condition which now exists after rains and which retards the growth of plants, especially when young.

A large proportion of the Susquehanna fine sandy loam is covered by a heavy growth of post and scrub oak. The soil is not as productive as the black prairie lands, but it is adapted to a greater variety of crops. It is especially adapted to watermelons, sweet potatoes, and peanuts. It is also well adapted to fruits, and the small orchards of peaches and plums located on the soil do well. Blackberries have also been grown on this type with excellent results. Vegetables are extensively grown for the local markets, but at present none are shipped outside the area. Cowpeas do well and have proved very beneficial to the land, especially where the vines are plowed under. The great destruction of cotton on this soil by the boll weevil during the four years preceding the season of 1905–6 has caused a much smaller acreage to be devoted to this crop. The boll weevil damaged a much larger percentage of the crop on the sandy soil than on the black prairie lands, and for several seasons the crop was almost a total loss. This encouraged diversification, and the growing of peanuts in connection with hog raising became an industry of considerable importance. Peanuts produced about 60 bushels per acre, but very few are marketed. The fields are fenced off, and the hogs are turned in and fattened on the crop. Watermelons are extensively grown for the local markets and have proved a profitable crop. Small shipments of melons have also been sent to outside markets. Tomatoes are successfully grown and excellent yields are obtained.

No fertilizers are used on this soil, and it is very seldom that any systematic rotation of crops is practiced.[a] Cotton gives an average yield of about one-third of a bale per acre. Corn during a season of average rainfall averages from 15 to 20 bushels per acre, but during a favorable season often produces 30 to 35 bushels per acre. Sorghum is grown for feed and yields an average of 3 tons per acre. Sweet potatoes give large yields, and all kinds of truck crops do exceedingly well. Grapes are grown to a limited extent for home use, and the soil seems well adapted to them.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Susquehanna fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14512, 14514, 14516.	Soil.....	0.5	1.1	1.6	42.3	32.8	13.6	8.0
14513, 14515, 14517.	Subsoil	.4	.5	1.1	22.8	20.7	10.6	43.4

HOUSTON CLAY.

The soil of the Houston clay is a dark-brown to black clay, with an average depth of 10 or 12 inches. Small fragments of partially decomposed limestone are often scattered over the surface. The upper part of the subsoil is a stiff, heavy drab clay, but as the depth increases it gradually changes into a soft chalky material until at a depth of 30 or 36 inches it is usually a soft powdery mass of decomposed white chalky limestone. In many small areas where the soil is shallow this chalky material has been turned up with the plow and mixed with the upper soil, giving it a dark-gray appearance. These areas usually occur on the slight elevations which have suffered to

[a] Samples of the Lufkin fine sandy loam were collected at points near Tilman and Lockhart, Tex., from fields which had been under cultivation for some time, producing without fertilizers crops of sorghum, cotton, and corn. In no case, however, has a systematic rotation been practiced, in one instance sorghum being grown for a number of years in succession with good yields. The yield of cotton is from one-third to one-half bale and of corn from 25 to 30 bushels when not affected by drought. No fertilizers have been used on either field.

From a study of this soil by the wire-basket method to determine its manurial requirements, the results clearly indicate the necessity of the application of fertilizing material in some form as an increase was noted in every case where such application was made. Nitrate of soda gave very beneficial results used alone or in combination with sulphate of potash or acid phosphate or with both. Stable manure gave the largest increase, that from cowpeas and lime being second, bringing out the necessity for keeping up the supply of humus in soils of this character, especially when supplied by nitrogen-carrying material. Lime alone was of some benefit, the increase from its use exceeding that obtained from either sulphate of potash or acid phosphate.

The results of this test, while no doubt applicable to all soils of this type, are held to be strictly applicable only to the fields from which the samples tested were obtained.

some extent from erosion, while in the shallow depressions the soil is deeper, darker in color, and is slightly heavier in texture.

The largest area of Houston clay occurs in one unbroken strip, comprising about 7 square miles, which is located in the northwestern corner of the area. A few smaller areas also occur along the bluffs of Plum Creek in the east-central part of the region surveyed. The surface of this type is more rolling than that of the black prairie belt, but it is seldom rough and hilly. The valleys between the rounded hills are narrow, and the small streams which occupy them have cut deep gullies through the soft underlying limestone. The soil is often badly eroded along the slopes of the hills and ridges, and small areas of the white chalky limestone are frequently exposed on the surface. The type as a whole is well drained, and some of the more rolling areas are excessively drained. On these areas the underlying rock is close to the surface, and the crops grown are often seriously damaged by droughts. The best results are always obtained on this soil during a wet season.

The Houston clay is formed from the decomposition of massive strata of soft chalky limestone of the Upper Cretaceous period, known as the Austin chalk. This formation decomposes rapidly, first breaking up into thin shaly layers and then thin, partially decomposed fragments become mixed with the soil or scattered over the surface. There is seldom any distinct boundary between the subsoil and the parent rock. The upper surface of the limestone is so thoroughly decomposed that it is easily penetrated with the soil auger and the soft, chalky fragments can be crushed between the fingers.

A large percentage of this type is still covered with its original forest growth of cedar, live oak, and a few post oaks. Only the more level or gently rolling areas are cultivated. A large proportion of the Houston clay is used as pasture land for stock, and the more rolling areas are valued chiefly for that purpose and for the natural timber growth. During a wet season very profitable yields are obtained on this soil, especially on the more level areas or those occupying the slight depressions where the soil has not been damaged by erosion. Cotton, corn, sorghum, and potatoes are successfully grown on this type. Oats are also grown to a very limited extent, the average yield being estimated at 30 bushels per acre. The average yield of cotton is about one-fourth to one-third of a bale per acre, but three-fourths of a bale per acre has been secured during a favorable season on the more level areas. Corn yields about 20 to 25 bushels per acre. The average yield is much larger than this during a wet season, but if the season is droughty the corn crop is a failure. Sorghum does fairly well, yielding from $2\frac{1}{2}$ to 3 tons of feed per acre. Sweet potatoes do fairly well, and during a very favorable season yield about 125 bushels per acre.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Houston clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14490, 14492	Soil	0.8	2.8	2.1	7.7	10.2	32.2	43.8
14491, 14493	Subsoil	2.7	5.1	2.8	7.8	10.1	26.1	45.0

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 14490, 9.6 per cent; No. 14491, 16.1 per cent; No. 14492, 1.1 per cent; No. 14493, 5.2 per cent.

CRAWFORD SILT CLAY.

The soil of the Crawford silt clay consists of a brown to reddish-brown clay loam with an average depth of 10 or 12 inches. This soil does not have a tendency to clod and bake like the Houston black clay, but breaks up into a loamy granular condition and is easily put into a very thorough state of cultivation. It grades at about 12 inches into a heavy silty clay subsoil slightly redder in color, which gradually becomes heavier as the depth increases. A few small, chalky particles of thoroughly decomposed limestone are encountered in the lower subsoil, and beds of rounded gravel cemented with a reddish marly material are sometimes found at a depth of 5 feet or more.

The soil is not as deep near the mountainous region as it is along the valley of the San Marcos River, and as it approaches the Crawford stony clay boundary the underlying limestone is frequently encountered at a depth of 4 to 6 feet. In these localities small fragments of limestone are occasionally found scattered on the surface, but over the main body of the type no rock fragments occur, either on the surface or in the soil. The heaviest phase of the Crawford silt clay occurs where the areas of Crawford silt clay join those of the Houston black clay. There is a gradual merging of the brown clay loam into the stiff black clay, and the texture of the soil near the boundary is slightly heavier than that of a typical section. The texture of this soil is also slightly modified by the addition of lighter material along its line of contact with the Blanco loam. These areas of lighter or heavier texture are too small to indicate on a map of the scale used, and the type as a whole is uniform in depth, color, texture, agricultural value, and topography.

The Crawford silt clay occurs in narrow areas along the base of the mountainous region in the western part of the area. It also occupies a considerable proportion of the more level country adjacent to the San Marcos and Blanco rivers, extending in an almost continuous body from where the Blanco River enters the area to where the San Marcos River leaves it at Fentress. The largest unbroken area is

situated just east of San Marcos and lies between the San Marcos and Blanco rivers. A few small isolated areas occur in the western part of the black prairie belt and small patches also on the west side of the San Marcos River. The larger areas, however, are situated on the eastern side of the river, and extend down the valley in a general southeasterly direction. The topography is very gently undulating or almost level, but the whole valley occupied by this type of soil slopes gently toward the small rivers. The position of the Crawford silt clay is sufficiently above the level of the neighboring river courses to insure good drainage. The areas are never overflowed, and water does not stand in the shallow depressions for any length of time after periods of heavy rainfall. Its position in the valley, the level topography, and the texture of the heavy subsoil enable it to conserve enough moisture for the production of good crops, and it is affected less by drought and hot winds than the heavy black clay soil occupying the rolling prairie. Irrigation, however, greatly increases the yields, and its location and topography, as well as its natural productiveness, make it the most important soil in the area for irrigation farming.

The material composing a large proportion of this type has been transported by floods in early times and laid down along the old flood valley through which the Blanco and San Marcos rivers now flow. A part of the type, however, is derived from the decomposition of the underlying limestone, which is encountered at no great depth below the surface along the base of the mountainous region and in some of the smaller areas. The beds of gravel which are sometimes found underneath the heavy subsoil, and the fact that the soil occupies the old river valley and follows the general course of the stream, indicate deposition by early floods, but the material deposited is similar to that derived from the limestone formations which occur at the base of the mountains, and undoubtedly owes its origin to the weathering of these rocks. A large part of this material was probably brought down by the floods which cut through the limestone hills of the western section of the area, forming the deep gorges of the Blanco River and Upper Sink Spring Creek, and which deposited over the more level areas east of the mountains the material held in suspension.

The Crawford silt clay is the principal truck soil of the area, and in the vicinity of San Marcos considerable areas of this soil are under irrigation and devoted to the production of onions. Other vegetables, as well as cotton, corn, and alfalfa, are grown on the irrigated areas of this type, but the principal crop is onions, which are grown on nearly all the areas now under irrigation. This soil is also considered excellent for general farming purposes, and almost the entire area embraced by it is under cultivation. Fertilizers are not used, except in the growing of onions and other special crops, on the irrigated land. The

average yield of onions on the irrigated soil is about 400 bushels per acre. Corn, irrigated, yields an average of 60 bushels per acre, and a yield of 105 bushels has been secured. When no irrigation is practiced, the average yield is about 35 or 40 bushels per acre. During the present season of 1905–6 the cotton was not damaged to any extent by the boll weevil, and an average yield of one-half to three-fourths of a bale per acre was secured. The limited acreage of cotton under irrigation is estimated to have averaged at least 1 bale per acre. On the irrigated land peanuts produce 120 bushels per acre and Irish potatoes 225 bushels per acre. Alfalfa also does exceedingly well. Nine cuttings were obtained on one irrigated field, with an average yield of three-fourths ton per acre for each cutting. Oats are grown to a limited extent on both the irrigated and unirrigated fields, the average yield being estimated at 60 to 70 bushels per acre irrigated and 40 to 50 bushels per acre unirrigated. Very little rotation of crops is practiced on the greater proportion of this soil used for general farming, and no fertilizers are used except for special crops. The soil continues to produce profitable yields even on fields which have been continuously planted in cotton for periods of ten years or more.[a]

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Crawford silt clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14219, 14482.....	Soil.....	0.3	0.7	0.7	3.7	8.3	58.0	27.7
14220, 14483.....	Subsoil....	.8	.8	.4	2.0	6.0	60.0	29.8

WABASH CLAY.

The soil of the Wabash clay is a heavy black clay with an average depth of 10 inches. This grades into a stiff, tenacious clay subsoil, which becomes heavier in texture and slightly lighter in color as the

[a] Three large samples of this soil were obtained from fields at points near San Marcos and Reedville, Tex. The first two from very productive fields, under irrigation, yielding good crops of cotton, peanuts, onions, and other vegetables; upon the remaining one cotton has been grown continuously for the past twelve years, yielding from one-third to one-half bale to the acre. No fertilizers have been used on any of the fields.

These samples were studied by the wire-basket method to determine their manurial requirements, the results showing very beneficial results from the use of a complete fertilizer to which lime was added. Manure and cowpeas and lime also gave a good increase. Lime used alone gave a very good increase, but its full beneficial effect was realized only when it was used with the complete fertilizer. Nitrate of soda alone gave an increase superior to either sulphate of potash or acid phosphate and its effects were to be seen in every combination into which it entered with either or both of those salts.

While these results are held to be strictly applicable only to the fields from which these samples are taken, yet they would no doubt be reliable for this type of soil throughout the area.

depth increases. This soil is very stiff and tenacious when wet, and on drying the surface becomes baked and sun-cracked. A few small areas occur in this type which contain a slightly higher percentage of sand than the typical soil. This is due to an admixture of sandy material brought down by small streams which traverse areas of Susquehanna fine sandy loam or Sandhill. These loamy areas, such as occur along the valley of Tenney Creek, are of very small extent, and are so intermingled with areas of the typical black clay that it was impracticable to attempt their separation into another type.

The largest area of the Wabash clay occupies the broad, flat valley of Plum Creek, but smaller areas extend up the valleys of all the principal creeks which traverse the black prairie section of this area. The surface of these valleys is almost level, having only a very gentle slope toward the stream courses, but their position is sufficiently above the present level of the stream channels to insure good drainage. These valleys are frequently overflowed during times of heavy rainfall, but the water is rapidly carried off by the small streams and the soil never remains in a wet or flooded condition for any length of time.

The Wabash clay is an alluvial soil. It is derived from material deposited by the adjacent streams during times of overflow. The small streams which traverse the black prairie region carry in suspension the fine material composing the heavy, black upland clays and deposit it during floods over the broad, flat valley lands bordering the principal streams. The soil is very productive and is capable of producing yields equal to those obtained on any type of soil in the area, but the crops grown on it are frequently damaged by floods. It is especially adapted to corn, and the crop is never a failure even during a dry season. The cotton crop is usually damaged by the boll weevil to a greater extent on this soil than on any other type in the area, as the rank growth of the plant and the damp, shady conditions which exist are especially favorable to the development of that insect.

When not damaged by the weevil cotton produces an average yield of from two-thirds of a bale to 1 bale per acre, but during the past few seasons the average yield has not exceeded one-half of a bale per acre. Corn produces about 40 bushels per acre, but when well cultivated a yield of 50 bushels or more per acre is not uncommon in favorable seasons. Sorghum is not as extensively grown on this soil as on the upland types, but produces large yields, and two cuttings are always secured. Oats are grown to a very limited extent, and when not damaged by floods give fairly good results. The deposition of new material over the broad, flat stream valleys during each annual overflow keeps the Wabash clay in a productive state, and when proper methods are used in its cultivation the surface is as loamy and as free from clods as that of the clay soils occupying the rolling uplands.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Wabash clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14518, 14520.....	Soil.....	0.3	0.5	0.5	5.3	9.6	45.2	38.1
14519, 14521.....	Subsoil....	.2	.4	1.3	11.1	11.7	42.7	32.3

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 14518, 4.3 per cent; No. 14519, 1.8 per cent; No. 14520, 6.1 per cent; No. 14521, 10 per cent.

CRAWFORD STONY CLAY.

The soil of the Crawford stony clay consists of a dark-brown to reddish-brown clay 8 or 10 inches deep, which grades into a stiff clay subsoil of a slightly redder color. The underlying limestone is seldom more than 2 to 4 feet below the surface, and large fragments of this rock are usually encountered in the subsoil at a depth of from 20 to 36 inches. Fragments of a hard honeycombed limestone and small fragments of chert are scattered over a large percentage of the surface and embedded in the soil, and the proportion of such material is so large that much of the type is unfit for agricultural purposes. The stones, however, are sometimes removed from small areas where the underlying limestone is 3 feet or more below the surface, and these areas are successfully cultivated to almost any crop grown in this locality. The soil here is productive and the surface is friable, free from clods, and gives a very desirable tilth.

The Crawford stony clay occurs in one continuous strip about 2 miles wide along the entire western boundary of the area. The topography is rough and broken, and the small streams have cut deep gorges through the underlying limestone. The hillsides are often steep and eroded, and small areas of rock outcrop occur frequently. The soil over the greater part of the hilly region is very shallow, and is easily eroded and washed from the steeper slopes.

The whole type is thoroughly drained by many small intermittent streams which occupy the narrow valleys, and if the soil was otherwise suitable for agricultural purposes a large proportion of it would be too thoroughly drained to produce the best crops. The type is derived from the decomposition of the Edwards formation, a hard white limestone which frequently contains bands of flint or chert embedded between the strata. This formation does not weather rapidly, and the harder fragments of limestone and chert are left scattered over the surface and mixed with the soil.

The Crawford stony clay supports an abundance of native grasses, and is well watered, making it excellently adapted to stock raising,

and almost the entire area embraced by this type is utilized for that industry. It is also valuable for the heavy growth of live oak and cedar which covers a large proportion of the type. The soil is well adapted to fruits, and the small orchards located on it do well. It seems better adapted to plums than to peaches or pears. Limited experiments with grapes have not proved successful, as the fruit is usually affected by some disease which causes it to rot before ripening, but grapes do well on a similar soil located a short distance north of the area surveyed. The limited acreage under cultivation produces fair yields of cotton, corn, and sorghum. Cotton gives an average yield of one-fourth to one-third of a bale per acre. Corn usually yields from 15 to 20 bushels per acre, and during a favorable season much larger yields are secured. Sorghum does well on this soil, producing from 2 to 3 tons of feed per acre. The Crawford stony clay which lies within the area surveyed is valued at about $10 an acre, because its nearness to the towns makes the timber available for fuel. West of the area surveyed the distance from the towns and railroads increases and the value of the land decreases.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Crawford stony clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14478, 14480.....	Soil.....	1.9	4.4	2.7	7.0	7.1	38.4	38.4
14479, 14481.....	Subsoil.....	1.0	2.5	1.5	4.1	4.9	41.0	44.9

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 14478, 2.0 per cent; No. 14479, 24.3 per cent; No. 14480, 2.1 per cent; No. 14481, 5.2 per cent.

HOUSTON LOAM.

The soil of the Houston loam to an average depth of 10 or 12 inches consists of a dark-gray to very light-brown loam containing a considerable quantity of very fine sand. A few small gravel frequently occur scattered over the surface, but never in sufficient quantity to affect the general character of the soil. The soil grades into a dark-drab heavy loam to silty clay which also often contains a large quantity of very fine sand. The subsoil becomes heavier with depth and at from 30 to 36 inches is a drab to dark-brown stiff silty clay which often contains a few small rounded gravel.

The Houston loam occurs in areas of more or less extent in almost every locality in the eastern part of the area where the light sandy soils come in contact with the heavy black prairie land. The texture of the soil varies slightly according to its position relative to the Susquehanna fine sandy loam and Houston black clay. The sand

content is greater along the line of contact with the Susquehanna fine sandy loam, while along the Houston black clay boundary the soil is slightly heavier. The subsoil is also influenced by these two opposite formations. Near the areas of light sandy soil the subsoil has a more decided brown color and its general appearance becomes more like that of the stiff clay underlying the Susquehanna fine sandy loam, while near the black prairie land it more closely resembles the subsoil of the Houston black clay. This condition has caused the Houston loam to be locally known as the "black sandy" or "mixed" land, as small areas less than a few rods in extent often occur throughout this type, which vary slightly in texture as the lighter or heavier material predominates. However, the greater proportion of the Houston loam is fairly uniform as to texture, general appearance, topographic features, and agricultural value. This soil is not so well adapted to general farming purposes as the Houston black clay, and requires more careful management than the heavier soils to keep it in a productive state; nor is it as well adapted to a diversity of crops as the Susquehanna fine sandy loam.

The topography is gently rolling and the hillsides are seldom seriously eroded. The natural drainage is good, and although shallow depressions occur in which water collects after heavy rains the soil never remains in a cold wet condition for any considerable length of time.

The material which forms the Houston loam is derived both from the heavy Cretaceous clay deposits which form the black prairie region and from the light sandy formations of the Eocene period which form the Susquehanna fine sandy loam and Sandhill. Wherever the sandy areas occur adjacent to the black prairies there is a gradual merging of the heavy black clay into the light sandy loam. The fine sand has been laid down over the heavy clay formation, and being mixed with the finer material forms the dark-gray loam which distinguishes this type of soil.

No fertilizers are used on this soil and no methods are employed to prevent the rapid evaporation of the soil moisture. The yields obtained are much smaller than this soil is capable of producing under careful management and with more thorough methods of cultivation. Small areas occur on this soil similar to those on the heavy clays where the cotton is damaged to a considerable extent by the "cotton root-rot."

The average yield of cotton is from one-third to one-half bale per acre, and a yield of three-fourths bale per acre is considered especially good. Corn yields from 18 to 25 bushels per acre in a season of average rainfall, but during a wet season 35 bushels per acre have been secured. Peanuts are grown to some extent, but do not do so well as on the Susquehanna fine sandy loam. The average yield is about

35 to 40 bushels per acre. The Houston loam is better adapted to Irish than to sweet potatoes, and very profitable yields of the former are usually secured. Vegetables, especially tomatoes, beans, and beets, are successfully grown on this type. Sorghum, which is grown for feed, gives two cuttings and yields from 2 to 3 tons per acre for the first and about half that for the second cutting.

The mesquite, the typical growth on the black prairie region, and the post oak, which is typical of the lighter soils, are both found on the Houston loam.

The following table gives the average results of mechanical analyses of samples of this type.

Mechanical analyses of Houston loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14486, 14488	Soil.....	0.2	0.7	1.1	18.6	47.3	20.5	11.3
14487, 14489	Subsoil.....	.4	.6	1.0	13.6	33.9	33.1	17.0

BLANCO LOAM.

The soil of the Blanco loam consists of a gray heavy loam to silt loam about 10 inches deep. When dry and baked a thin gray crust is formed on the surface, but when wet or recently cultivated the surface has a very light brown appearance. This soil grades into a light-brown heavy loam to silt loam subsoil, which gradually becomes heavier as the depth increases and at from 30 to 36 inches changes to a heavy plastic silty loam of a more decided brown color than the upper soil.

The Blanco loam occurs along the Blanco and San Marcos rivers, but seldom extends back more than one-quarter or one-half of a mile from the immediate banks of the stream. The largest areas occur in the big bends of the San Marcos River near Fentress, in the southern part of the survey. The topography is almost level, with a gentle slope toward the stream, and the soil is high enough above the level of the streams to insure good drainage. Its position along the stream courses and its level topography make it possible for the whole of this type to be put under irrigation, but at present only small areas in the vicinity of San Marcos and Martindale are irrigated. The soil is formed from material deposited by the rivers during overflows in comparatively recent time, and some of the areas occupied by this type are at present occasionally overflowed by the San Marcos River.

The soil is well adapted to the general farm crops grown in the area, as well as to vegetables, but its limited acreage in any one locality causes it to be of minor importance among the soils of the

area. When cotton is not damaged by the boll weevil the Blanco loam yields from one-half to three-fourths of a bale per acre on the unirrigated areas, and from three-fourths of a bale to 1 bale is estimated as an average yield where irrigation is practiced. The cotton was not seriously damaged by the boll weevil during the season of 1905, but during the preceding four seasons the average yield on this type was only about one-fourth of a bale per acre. Corn produces from 25 to 35 bushels per acre on the unirrigated land, but where irrigated about 50 or 60 bushels is estimated as an average yield. Irish potatoes give excellent yields, and sweet potatoes also do fairly well. From 3 to 6 cuttings are obtained from alfalfa grown on the irrigated areas of this soil, the average yield being estimated at one-half ton per acre for each cutting. As a general rule, no fertilizers are used on the Blanco loam, and very little rotation of crops is practiced.[a]

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Blanco loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14221, 14474.....	Soil.....	0.3	1.2	1.8	9.2	13.3	46.1	27.9
14222, 14475.....	Subsoil.....	.4	1.0	1.7	8.3	13.8	43.8	30.5

The following samples contain more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 14474, 11.6 per cent; No. 14475, 11.8 per cent.

SANDHILL.

The soil of the areas mapped as Sandhill consists of a gray to white fine to medium sand which has an average depth of 10 or 12 inches. The subsoil is of a slightly yellow color, but has the same texture as the soil. Both soil and subsoil are of a loose and incoherent nature. This soil is most typically developed in the southeastern

[a] A large sample of this soil was obtained from a field 1½ miles northeast of San Marcos, Tex., which has been under cultivation for the last twenty years, producing cotton and corn, the former being grown two years in succession, followed by the latter for one year. The yield of cotton is from one-fourth to one-third bale and of corn 25 to 30 bushels per acre, no fertilizer being used.

The results of the examination of this sample by the wire-basket method indicate the desirability of introducing a green manuring crop into the rotation, the largest increase being observed where cowpeas were used for this purpose, the soil also receiving an application of lime. Nitrate of soda, sulphate of potash, acid phosphate, and lime, used singly and in various combinations, produced increased yields, the greatest increase from them being obtained from a combination of all four; manure also gave considerable increase; but neither equaled that derived from the use of cowpeas and lime. These results are held to be strictly applicable only to the field from which the sample was taken, but may apply equally to this soil type in this area generally.

part of the area, where the main body of it is found, but five smaller areas occur in the survey, two being found a short distance southeast of Dale and three in the vicinity of Tilmon.

This type of soil occupies small hills, mounds, or ridges which are locally known as "sand hills." Owing to its hilly topography and to the loose, incoherent condition of both the soil and subsoil, it is excessively drained and does not retain sufficient moisture for the successful production of any of the staple crops.

The soil is derived from deposits of white quartz sand and from the weathering of a brown ferruginous sandstone, both of which probably belong to the Eocene period. A series of knobs and small, rounded elevations occur in the larger area of this type. These are usually capped by strata of massive brown sandstone, and many small fragments of partially decomposed sandstone are encountered on the surface and in the soil on most of the lower mounds and ridges.

Practically all of the Sandhill areas are at present covered by a heavy growth of black-jack and post-oak timber, the acreage under cultivation being estimated at less than 1 per cent of the total area of the type.

Of the crops grown, the soil is regarded as best adapted to watermelons, but these can not be marketed to advantage, owing to the distance of the "sand hills" from the local markets and the railroads. Peanuts and cowpeas can also be successfully grown. These crops are sometimes grown in connection with the raising of hogs, which is the most profitable industry of this section of the area. Sweet potatoes sometimes give fair yields, but cotton averages only about 1 bale to every 6 or 8 acres. Corn does not give good results in a season of average rainfall and is seldom planted. Plowing on this soil should be very shallow in order that the deeper soil may be kept as firm and compact as possible and thus aid it to conserve the soil moisture. The type is valued mainly for its timber growth and is of minor importance.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Sandhill.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14508, 14510.....	Soil.....	1.4	13.9	12.7	51.3	9.1	8.7	2.5
14509, 14511.....	Subsoil	1.5	14.0	11.5	49.9	9.7	10.0	3.1

SUSQUEHANNA GRAVEL.

The Susquehanna gravel consists of a mass of rounded gravel and small cobbles which usually has a shallow covering of fine sand on the surface. A small amount of fine sand is also mixed with the gravel

deposit. The depth of these gravel beds varies from 12 inches to several feet, and they are usually underlain by a reddish-brown or dark-drab clay. The type occupies a few low ridges in the eastern and southeastern parts of the area surveyed, and, like the Houston loam, is generally found near the boundary between the lighter soils and the black prairie belt. It occupies rounded knolls and long, low ridges and considerable erosion has taken place on some of the steeper slopes.

A heavy growth of post oak covers the greater part of the type and it is not cultivated at present, except in small areas along its line of contact with some other type of soil, where the gravel content is much lower than on the typical areas.

These gravel beds are probably derived from the ancient gravel deposits which are found occupying the higher elevations in the black prairie region, and the fine sand which occurs on the surface and mixed with the gravel owes its origin to the sand and sandstone formations from which the Sandhill and Susquehanna fine sandy loam are derived. These gravelly ridges support an abundance of native grasses and are utilized mainly for pasturage. The heavy growth of timber which the Susquehanna gravel supports adds considerably to its value, especially where the areas occur near some of the smaller towns. No typical areas of this soil are under cultivation, and the small cultivated tracts occurring near the boundary line of other soil types are not at all productive and the crops suffer greatly from drought. Fruit trees should do fairly well on this type, but it is not adapted to the cultivation of any of the general farm crops grown in the area, both on account of its gravelly texture and because its topography and porosity cause it to be too thoroughly drained for agricultural purposes except in seasons of unusual rainfall.

ROCK OUTCROP.

A small area of rock outcrop is shown in the map. In all, about one-tenth of 1 per cent of the area surveyed is of this character of surface. Aside from being purely nonagricultural, its insignificant extent makes it a negligible feature of the soil survey work.

IRRIGATION.

Irrigation was first practiced in this area about 1902, and the number of acres under irrigation has steadily increased until at the present time (1906) 2,456 acres are irrigated, all of which is located in the valley of the San Marcos River, between San Marcos and Martindale. The water supply is derived mainly from the San Marcos River, which has its rise in a series of large springs at the base of a limestone bluff about one-half mile north of San Marcos. There is scarcely any variation in the amount of water furnished by this stream during any month of the year, and measurements taken at regular intervals

near the head of the river have indicated that the average flow of water from these springs is about 17,128 cubic feet per minute.

The Blanco River, which rises in the mountainous region west of the area, empties into the San Marcos River a few miles below the source of the latter stream. The Blanco is never dry during any season of the year and furnishes an abundance of water for the irrigation of the level valley lands bordering it. About one-half mile above the head of the San Marcos River, in the valley of Sink Spring Creek, there is a deep cave or "sink hole," which contains an apparently inexhaustible supply of water. There is no surface outlet to this large spring, but a very large amount of water has been pumped out without lowering the surface a fraction of an inch. The source of this water is supposed to be identical with that of the San Marcos River, and there is apparently direct connection between this "sink hole" and the large springs at the head of the river. The water from this cavern is now used to irrigate several hundred acres in a broad cove situated a short distance up the valley. Several of the pumping plants in the vicinity of San Marcos are equipped with small dynamos, which are connected with the electric power house of the city. The others are run by water power, which is usually obtained at the cotton gins located along the San Marcos River. From these stations the water is pumped to small distributing tanks and is carried by canals or large flumes to all sections of the irrigated farms.

There is approximately 11,000 acres of irrigable land situated in the valley of the San Marcos River between the city of San Marcos and the town of Martindale, located 7 miles down the river. Only a very small percentage of this area is located on the western side of the river, as the topography of the black prairies, which extend almost to the bluffs of the river, is too rolling to permit of irrigation. The acreage of irrigable land in the river valley between Martindale and the southern boundary of the area is not so large, but extensive areas in the vicinity of Fentress, especially the areas of Blanco loam which occur in the big bends of the river, could be easily and profitably put under irrigation. Plum Creek, in the eastern part of the survey, would furnish an abundance of water for the irrigation of the broad, level areas of Wabash clay which occupy its valley, but the fact that these valley lands are subject to overflow at times of heavy rainfall makes irrigation impracticable.

In irrigating the land the water is brought to the fields in canals and is distributed by means of lateral ditches, which are usually about 300 feet apart. Two methods of applying the water are practiced in the area. The method in general use consists of laying off the fields in rectangular checks bordered by low ridges. The water from the lateral ditch is allowed to flood the checks and spread out over the surface, the low ridges holding it like a shallow reservoir. By the second method the lateral ditches are included between two ridges several feet high thrown up parallel to each other, forming a narrow

V-shaped ditch whose sides are above the level of the field. A small stream of water is carried from this ditch to shallow furrows, between the narrow beds on which the crop is planted, by means of small pipes which penetrate the walls of the canal at regular intervals. These pipes are only a few feet long and extend a few inches through the inner wall of the ditch, so as to prevent their being filled with soil washed from the sides of the ridge. The flow of water in the shallow furrows is slow. The plants are not flooded, but the water is allowed to saturate the soil slowly and reach the plants by capillarity. This method is not in general use, but is being practiced in the areas which are being put under irrigation at the present time.

In growing onions, other vegetables, alfalfa, and corn the crops are irrigated on an average of once in every six weeks. Potatoes as a rule require more water than the other crops, while cotton requires less. The cotton is only irrigated three times—first when planted, then when it is thinned out, and last when the bolls begin to form. The average cost of installing irrigation systems in this area, including pumping plants, flumes, the construction of canals, and the leveling of the land, is estimated by those engaged in this work to be from $50 to $60 an acre. Irrigation greatly increases the yields of the staple crops as well as of alfalfa, and this fact, together with the growth of the trucking industry, will eventually cause it to be practiced on all the irrigable lands of the area.

SUMMARY.

The area surveyed is located in south-central Texas, comprises about 515 square miles, and includes parts of the black prairie belt, the east Texas timber belt, and the rough and hilly section locally known as the "mountains." The topographic features vary from rough and broken limestone hills to very gently rolling or almost level prairies.

The climate is mild and the rainfall is usually sufficient for the production of all crops grown, but irrigation is practiced on the bottom lands because it has been found that the increased yields of all crops more than compensate for the cost of irrigating. The area is well watered and drained by two rivers and many large creeks. The San Marcos and Blanco rivers furnish sufficient water for all the irrigable lands in their valleys. There are 2,456 acres under irrigation at present, and other large areas suitable for irrigation occur along the San Marcos River.

The area is comparatively thickly settled and its population is steadily increasing. A large percentage of the total area is under cultivation, the open range has been fenced off into small farms, and stock raising is now of minor importance. The only lands used for pasturage are those least adapted to agricultural purposes.

Cotton is the principal product of the area, but sugar cane, sorghum, peanuts, oats, alfalfa, Johnson grass, fruits, small fruits, and vegetables are also successfully grown. The growing of onions and other truck on irrigated areas is rapidly becoming an important industry and large shipments are annually sent to northern markets.

Three railroads—the International and Great Northern, the Missouri, Kansas and Texas, and the San Antonio and Aransas Pass—traverse the area and furnish ample facilities for transporting its products to distant markets.

Mexican labor is generally employed, and is cheap, intelligent, and usually plentiful. Very little rotation of crops is practiced and no fertilizers are used in general farming, but the soils remain productive and annually yield good crops. Cotton is produced on every type of soil in the area and in some cases has been grown continuously on the same field for periods of from fifteen to twenty-five years.

Eleven types of soil were mapped in the survey, varying in texture from loose, incoherent sand to very heavy clays. The various types are adapted to a great diversity of crops and range in agricultural value from gravelly or stony soils used mainly for pasturage to very productive clays or clay loams which are highly improved and thoroughly cultivated.

The Houston black clay is the most valuable general farming soil in the area, being very productive and extremely durable. It produces profitable yields of cotton, corn, and forage crops. Cotton yields from one-half to 1 bale and corn from 35 to 50 bushels per acre, depending on the season. Johnson grass and sorghum both yield from 3 to 6 tons of hay or forage per acre. Cotton is the principal crop on this soil. Corn is sometimes damaged by drought. The average price of this type is $40 an acre.

The Houston gravelly clay is very productive, but is not valued as highly as the Houston black clay because the gravel makes it more difficult to cultivate. Cotton, corn, sorghum, and Johnson grass are the principal crops. Cotton yields an average of one-half bale per acre and is seldom damaged to any great extent by the boll weevil. Corn yields from 35 to 50 bushels per acre, according to the season. Sorghum yields an average of 4½ tons per acre. Johnson grass is grown for feed, but is very difficult to kill when it has once been sown. This land brings from $25 to $40 an acre.

The Susquehanna fine sandy loam is not as productive as the black prairie lands, but is adapted to a greater variety of crops, especially to watermelons, sweet potatoes, and peanuts. Peaches, plums, blackberries, tomatoes, and cowpeas all do well. Very little cotton has been grown in recent years, because the damage from the boll weevil is much greater on this than on the black prairie soil.

A large percentage of the Houston clay is covered with its original forest growth and only the level or gently rolling areas are cultivated. Cotton, corn, sorghum, and potatoes are successfully grown, and oats are also grown to a limited extent. During a wet season good yields are obtained.

The Crawford silt clay is the most important soil in the area for irrigation farming, and is the principal trucking soil. In the vicinity of San Marcos a considerable acreage is irrigated and used for onions. It is also an excellent general farming soil. Under irrigation it yields about 400 bushels of onions, from 60 to 105 bushels of corn, 1 bale of cotton, 120 bushels of peanuts, 225 bushels of Irish potatoes, 7 tons of alfalfa, and 60 to 70 bushels of oats per acre. Without irrigation corn produces 35 or 40 bushels, cotton one-half to three-fourths of a bale, and oats from 40 to 50 bushels per acre.

The Wabash clay is very productive, but the crops grown on it are frequently damaged by floods. It is especially adapted to corn and the crop is never a failure even during a dry season. The yield is from 40 to 50 bushels per acre. The cotton crop is usually damaged by the boll weevil to a greater extent than on any other type, but when not damaged produces an average of from two-thirds to 1 bale per acre.

A great part of the Crawford stony clay is unfit for agricultural purposes because of its stony character. It supports an abundance of native grasses and is well watered, making it excellently adapted to stock raising, and almost all of it is utilized for that industry. Some parts of it are also valuable for the heavy growth of live oak and cedar.

The Houston loam requires more careful management than the heavier soils to keep it in a productive state, and is not as well adapted to a diversity of crops as the Susquehanna fine sandy loam. The average yield of cotton is from one-third to one-half of a bale per acre, of corn from 18 to 25 bushels, of peanuts from 35 to 40 bushels, and of sorghum from 3 to 4½ tons per acre. The limited acreage of the Blanco loam causes it to be of minor importance among the soils of the area. Corn, cotton, and sweet and Irish potatoes are the principal crops grown on it.

Practically all of the areas of Sandhill are at present covered by a heavy growth of black-jack and post-oak timber, the acreage under cultivation being estimated at less than 1 per cent of the total area of the type.

A heavy growth of post oak covers the greater part of the Susquehanna gravel and it is not cultivated at present, except in small areas along its line of contact with some other type of soil, where the gravel content is much lower than in the typical areas.

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BUREAU OF SOILS
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SOIL MAP

TEXAS
SAN MARCOS SHEET

SOIL PROFILE
(3 feet deep)

Houston gravelly clay
Hc
He

Houston loam
L
Hl
Sic

Houston clay
C
Hc
C

Houston black clay
Hc
Hc
Hc

Crawford stony clay
C
C

Crawford silt clay
Cl
Hsic

Susquehanna gravel
Gr
C

Susquehanna fine sandy loam
Fsl
C

Blanco loam
Hl
Hl
Hsil

Wabash clay
Hc
Hc

Sandhill
S
S

LEGEND

Gr	Gravel
C	Clay
S	Sand
Fsl	Fine sandy loam
Hl	Heavy loam
Hsil	Heavy silt loam
L	Loam
Sic	Silty clay
Hc	Heavy clay
Cl	Clay loam
Hsic	Heavy silty clay

LEGEND

Houston gravelly clay
Houston loam
Houston clay
Houston black clay
Crawford stony clay
Crawford silt clay
Susquehanna gravel
Susquehanna fine sandy loam
Blanco loam
Wabash clay
Sandhill
Rock outcrop

Soils surveyed by
A.W. Mangum and W.S. Lyman.
1906.

Scale 1 inch = 1 mile

Field Operations
Bureau of Soils
1906.